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ALASKA ICE SEAL RESEARCH PLAN
FY2009

A COORDINATED PLAN FOR RESEARCH ON ICE-ASSOCIATED SEALS IN ALASKA, INCLUDING ACCOMPLISHMENTS AND CRITICAL UNFUNDED RESEARCH

Prepared jointly by

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National Marine Fisheries Service
Alaska Department of Fish and Game
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Alaska Ice Seal Research Plan, FY 2009

EXECUTIVE SUMMARY

Four species of ice-associated seals, spotted (*Phoca largha*), ribbon (*Histriophoca fasciata*), ringed (*Phoca hispida*), and bearded seals (*Erignathus barbatus*), inhabit the Bering, Chukchi, and Beaufort seas of the Alaskan Arctic. Collectively, they are known as ice seals and despite the fact that these seals are vital resources for Alaska Native communities, as well as key ecological components of arctic marine ecosystems, relatively little is known of the seals' population status, stock structure, trends in abundance, life history, seasonal movements, diving behavior, diet or harvest rates. Ice seals are highly dependent on suitable sea ice condition and distribution, and therefore may be particularly vulnerable to climatic change, offshore oil development, or other environmental impacts that could alter their habitat.

The Ice Seal Research Plan is a consolidated plan for all Alaskan ice seal research funded in whole or in part through the NOAA Fisheries (NMFS) budget. Research on Alaska's ice seals is carried out principally by NMFS, Alaska Department of Fish and Game (ADF&G), University of Alaska Southeast, and the Alaska Native Regions represented by the Ice Seal Committee (North Slope Borough, Maniilaq, Kawerak, Bristol Bay Native Association, and the Association of Village Council Presidents). The combined research efforts by these groups focus on ice seal population abundance and trends, harvest, stock identification, general biology and life history, and human interactions. The principal objectives of the research plan are to:

1. Consolidate currently-funded projects into a single coordinated effort with maximum relevance to management objectives;
2. Describe additional research projects that are currently unfunded, but for which funds are critically needed;
3. Increase the dialogue, coordination, and collaboration among interested parties through the process of annually reviewing, evaluating and updating the research plan.

The Research Plan for FY 2009 describes 12 current and ongoing projects and an additional 10 project proposals that identify and address specific research needs, including the identity and status of ice seal populations, the comprehensive assessment of ice seal mortality including harvest, and the impact of industrial & climatological events on ice seal habitat. **The project topics, and the amounts required to support these important projects are listed in Table F.1.**

The Research Plan plays a key role in the co-management process put in place by the Ice Seal Committee and NMFS. The Plan enhances communication between the research agencies and the Ice Seal Committee by establishing a framework that will assist in setting priorities and tracking performance of research projects. The plan is also expected to provide helpful information to the Alaska Scientific Review Group about ice seal population status and research.

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A. INTRODUCTION

A.1 Background

Four species of ice-associated seals -- spotted seals (*Phoca largha*), ribbon seals (*Histriophoca fasciata*), ringed seals (*Phoca hispida*), and bearded seals (*Erignathus barbatus*) -- inhabit the Bering, Chukchi, and Beaufort seas (Burns 1970). These species have been important in the subsistence economy of northern people for thousands of years (Hall 1866; Murdoch 1885; Boas 1888; Rozanov 1931; Cox and Spiess 1980; Freeman 1984; Wenzel 1984), and large numbers were commercially harvested by the former Soviet Union in the 1960's (Shustov 1965, 1972; Mineev 1975, 1984). Threats to the populations include offshore oil development (Kelly 1988a,b,c; Quakenbush 1988) and reductions in sea ice associated with climate change. Sea ice is critical habitat to ice-associated seals (Fay 1974), and changes in snow and ice cover of polar waters may have severe impacts on those species (Tynan and DeMaster 1997; Kelly 2001; Smith and Harwood 2001; Stirling and Smith 2004; Ferguson et al. 2005).

Subsistence hunters have extensive knowledge of ice-associated seals (Nelson 1969; Krupnik 1978; Huntington 2000) and have contributed traditional knowledge to scientific research and management through interviews, contributions of biological samples, and participation in scientific field projects (Allen 1880; Nelson 1887; Johnson et al. 1966; Lowry et al. 1980a,b; Whiting et al. 2007). Despite the interests of subsistence users, scientists, and managers, ice-associated seals have been little investigated and many basic questions concerning their ecology and population status are unanswered.

A.2 Management Needs

Although none of the ice seal species in Alaska are listed as endangered or threatened under the Endangered Species Act (ESA), or as depleted under the Marine Mammal Protection Act (MMPA), these laws provide the statutory context for critical objectives of monitoring and managing these special resources. The ESA took on potential new relevance to ice seal management in December, 2006, when the U.S. Fish and Wildlife Service proposed listing of polar bears as threatened, because of concerns about the effect of receding sea ice on polar bear populations (http://www.doi.gov/news/06_News_Releases/061227.html). Because ringed seals are the primary prey of polar bears, and are themselves highly dependent on sea ice, they are intricately tied to the fate of the arctic ecosystem in this period of rapid change (Richter-Menge et al. 2006). The MMPA requires that marine mammals be managed to ensure that they retain their function in the ecosystem, and furthermore that species harvested for subsistence by Alaska Natives be managed to ensure a sustainable harvest. The goals espoused by these statutes were established in recognition of the importance of ice seals to the integrity of a vast ecosystem and to the sustainability of human cultures that evolved as part of that ecosystem. These goals transcend the relatively simple economic values that are the basis for management of many natural resources.

In 1984, the Marine Mammal Commission established working groups for marine mammals in Alaska (Twiss et al. 1988). For ice-associated seals, the working groups rated the importance of key conservation tasks as "critically important," "essential," or "necessary," (Table A.1) and they estimated annual costs for the necessary, essential, and critical tasks for the ice-associated seals at $200,000 - $537,000 (1984 dollars) for each species. None-the-less, appropriations for research have been totally lacking in most years and have only recently begun to approach these levels, even though it is now widely recognized that the need for information has become broader and more urgent because of the rapidly changing arctic climate.

Table A.1. Research tasks identified by a working group for ice-associated seals in 1984. Tasks were rated as "critically important," "essential," or "necessary" to known or possible conservation problems (Twiss et al. 1988).

Task	**Ringed seals**	**Spotted seals**	**Ribbon seals**	**Bearded seals**
Monitor harvest	Essential	Essential / critical	Essential / critical	Essential
Determine population discreteness	Essential	Necessary	Necessary	Essential
Estimate population size	Essential	Critical		Essential
Determine habitat requirements	Essential	Necessary	Necessary	
Monitor population size	Essential	Necessary	Necessary	Essential

In 1994, the National Science Foundation, the National Oceanographic and Atmospheric Administration, the Office of Naval Research, Texas A & M University, the University of Alaska, the U. S. Marine Mammal Commission, the Minerals Management Service, the North Slope Borough, and the Alaska Sea Grant Program sponsored a workshop entitled "Use of Ice-associated Seals in the Bering and Chukchi Seas as Indicators of Environmental Change" (Davis 1996). That workshop produced five "near-term action items:"

1. Update the research and management recommendations of the Marine Mammal Commission (Kelly 1988a,b,c; Quakenbush 1988; Twiss et al. 1988).
2. Create an ice seal database.
3. Reinitiate data collection from subsistence harvests.
4. Identify syntheses necessary to refine future research hypotheses.
5. Contrast importance of environmental factors influencing distribution and life history parameters of ringed and spotted seals.

In 2004, the Ice Seal Committee was formed to represent subsistence hunters of ice seals from five Alaska Native Regions: North Slope Borough, Maniilaq, Kawerak, Bristol Bay Native Association, and the Association of Village Council Presidents. An Ice Seal Working Group, composed of members from the National Marine Fisheries Service, the Alaska Department of Fish and Game, and the Ice Seal Committee identified the following research needs:

- Population status and trends
- Contaminants and their source
- Health of seal populations
- Harvest data
- Hunter education
- Climate change
- Individual animal health anomalies
- Community feedback of results

In response to those needs, the Working Group drafted this Ice Seal Research Plan and recommended an overall approach that emphasizes 1) defining the identity and status of ice seal populations, 2) the comprehensive assessment of ice seal mortality including harvest, 3) and the impact of industrial & climatological events on ice seal habitat and ecology.

The following sections provide a description of ongoing projects that are currently funded or partially funded, a description of proposed high-priority projects for which funding is sought, and a summary of completed projects as a context for the ongoing and proposed research.

B. CURRENT PROJECTS

B.1 Population identity and status

B.1.1. Ice Seal Life History Studies

Objective: Collect samples from the subsistence harvest to assess life history parameters, population status and health of ringed, bearded, spotted and ribbon seals. Determine the levels of persistent organic compounds (OCs) such as PCB, DDT, HCLs, and trace elements, in seal tissues by species and harvest location. Identify prey remains from stomachs to determine diet. Determine reproductive rate, age at first pregnancy, growth rate, and body condition. Determine the prevalence of antibodies from selected diseases in seal blood from seals harvested at Little Diomede and investigate physical anomalies from seals harvested in all villages participating in the ADF&G biomonitoring program. Collect traditional knowledge and current information on seal availability, distribution, harvest patterns, and hunter preference.

Justification: There is little information available about abundance and population status for any species of ice seal. Diet and contaminant loads are important in determining health. Contaminant levels can be high in the Arctic due to atmospheric transport even though the compounds have not been manufactured or used there. Many of the compounds are lipophilic and concentrate in marine mammal blubber. Reproductive rate, age at first pregnancy, growth rate, and body condition can be used to assess population status. Genetics are important in determining the structure, history, and vulnerability of the populations. Antibodies for certain diseases may be present in the population even if the disease itself is unknown. The presence of antibodies indicates that individuals have been exposed to the disease. Investigating physical abnormalities can help to detect health issues within the population.

Methods: Tissues are collected (teeth, stomach, liver, kidney, blubber, muscle, female reproductive tracts, skin, blood) from the subsistence harvest. Tissues are analyzed for age, diet, contaminants, productivity, and genetics. Traditional knowledge information is collected through a questionnaire filled out by hunters.

Products:

Quakenbush, L. and G. Sheffield. 2003. Ice Seal Monitoring in the Bering Sea Region. Report by ADF&G to NOAA. Project No. NA16FX2034

Quakenbush, L. and G. Sheffield. 2004. Ice Seal Monitoring in the Bering Sea Region. Report by ADF&G to NOAA. Project No. NA16FX2034

Quakenbush, L. and G. Sheffield. 2005. Ice Seal Monitoring in the Bering Sea Region. Report by ADF&G to NOAA. Project No. NA16FX2034

Quakenbush, L. and G. Sheffield. 2005. Ice Seal Monitoring in the Bering Sea Region. Final Report by ADF&G to NOAA. Project No. NA16FX2034
Quakenbush, L. and G. Sheffield. 2005. Ice Seal Bio-Monitoring in the Bering-Chukchi Sea Region. Report by ADF&G to NPRB
Sheffield, G. 2004. Traditional knowledge regarding seals and seal hunting. Performance Report to NSF Office of Polar Programs, OPP Grant 9910319, Washington, DC.
Quakenbush, L. T. 2005. Polybrominated diphenyl ether (PBDE) compounds in blubber from the Bering Sea subsistence harvest of ice seals in Alaska. Abstract. 16th Biennial Conference on the Biology of Marine Mammals. December 2005. Society for Marine Mammalogy.
O' Corry-Crowe and C. Bonin. 2004. The molecular ecology of marine mammals in the Bering Strait: A pilot investigation of ribbon seals, Phoca fasciata. Final Report by NMFS Southwest Fisheries Science Center/Aquatic Farms Inc., to the Alaska Department of Fish and GameFairbanks, AK. 5 pp.
O' Corry-Crowe, A. Frey, and K. Coultrup. 2003. Molecular genetic study of population.structure and dispersal patterns in four species of ice seal in the Bering, Chukchi, and Beaufort seas - feasibility analysis. Final Report by NMFS Southwest Fisheries Science Center/Aquatic Farms Inc., to the Alaska Department of Fish and Game, Fairbanks, AK. 5 pp.
Bracht, A.J., Brudek, R.L., R.Y. Ewing, C.A. Manire, K.A. Burek, C. Rosa, K.B. Beckmen, J.E. Maruniak, and C.H. Romero. 2005. Genetic identification of novel poxviruses of cetaceans and pinnipeds. Archives of Virology, DOI 10.1007/s00705-005-0679-6

Five-year project status: Funded by NOAA in 2003-2008, NSF 2000-2006 and NPRB in 2005-2006, USFWS Tribal Wildlife Grant 2004-2006, Kotzebue IRA.

Project Lead: ADF&G

Partners: Hunters from Barrow, Pt. Hope, Shishmaref, Diomede, Nome, Gambell, Savoonga, and Hooper Bay.

B.1.2. Population structure and seasonal movements of ringed seals

Objective: Determine the degree of fidelity to breeding sites by ringed seals and whether site fidelity reflects philopatry.

Justification: Recent observations of tagged ringed seals indicate that they maintain small breeding home ranges (averaging 1 km^2) and that they use the same breeding sites in successive years. If the sites breeding seals return to are, in fact, their own natal sites, then the population likely consists of multiple demographically isolated units.

Methods: Satellite-linked transmitters will be used to follow the inter-annual movements of ringed seals. The transmitters will be attached to the seals using flipper tags, thereby allowing the seals to be tracked for periods longer than one annual molt cycle (the limitation imposed by gluing transmitters to the seals' hair). DNA collected as bits of molted skin from seals in their breeding sites will be analyzed and compared with samples collected at other breeding sites.

Products:

Kelly, B. P., and P. L. Boveng. 2005. Ice Seal Movements and Stock Structure in a Changing Cryosphere. Semi-annual progress report to North Pacific Research Board. http://doc.nprb.org/web/05_prjs/515_pr_june05.pdf
Kelly, B. P., and P. L. Boveng. 2007. Ice Seal Movements and Stock Structure in a Changing Cryosphere. Semi-annual progress report to North Pacific Research Board. http://doc.nprb.org/web/05_prjs/515_pr_jul07.pdf

Five-year project status: Funded by North Pacific Research Board and NMFS/NMML in FY2005-2007.
Project partners: University of Alaska Southeast, NMML/NMFS, Ice Seal Committee, North Slope Borough, Central Michigan Univ.

B.2 Mortality and harvest

B.2.1. Development of a harvest monitoring program for ice seals
Objective: Document the harvest of ice seals, by species, sex, and time of year in selected communities. Determine the best method for documentation of harvest in each community. Provide support for a representative of each community to attend Ice Seal Committee meetings for reporting on and exchanging information about harvest.
Justification: Ice seal harvest data have not been consistently collected since the 1970s. Some regions conduct household subsistence surveys that include ice seals along with fish, birds, and land mammals. Many seals are harvested per year by some households, and detailed information about sex and species are not available using this format. For example, most of these surveys are not repeated annually.
Methods: A Harvest Calendar has been developed to assist hunters in recording their seal harvests weekly by sex and species on the calendar. When each monthly page is completed, it is torn off and mailed in for prize-drawings. Other methods will be explored by workshops and visits with hunters.
Products: 6-month test calendar in Togiak, Point Hope, Hooper Bay.
Five-year project status: Funded by NMFS, Alaska Region 2005-2006; ADFG 2006-2009.
Project Lead: ADF&G
Partners: Ice Seal Committee

B.2.2. Beaufort Sea ice seal sampling and archival project
Objective: This Project will archive full biological sample sets from subsistence harvested ice seals in the communities of Barrow, Nuiqsut, and Kaktovik, Alaska. Samples will be analyzed in cooperation with the Alaska Department of Fish and Game Marine Mammal Program and some tissues stored at the University of Alaska Museum of the North. This is first year of the project with long-term expectations of developing an annual program to obtain future, long-term data and information on the health of ice seal populations.
Justification: Seals are a key ecological component of the Arctic and are heavily relied upon by polar bears and northern indigenous people for food. Measurable impacts from climate changes effecting ice and foraging habitat and offshore oil and gas exploration and development effecting health and movements of seals may be attained from tissue sampling. Some past data from the 1970s and 1980s may be used for temporal health comparisons.
Methods: Seal hunting households are instructed in tissue sampling and measurements and given sample kits and data-forms. Samples are frozen and sent to Fairbanks for processing and long-term storage.
Products: Analysis of stomachs contents, teeth aging, contaminate loads, diseases will be conducted in partnership with ADF&G Ice Seal Biomonitoring Program. Other tissues will be stored long-term with the University of Alaska Museum of the North for future studies and comparisons.

Five Year Project Status: Partially funded FY2006-2007; unfunded 2008-2009
Project Partners: Alaska Nanuuq Commission, ADF&G, NSB Wildlife Management, Local Tribes

B.3 Habitat and climate change

B.3.1. Fatty acid study of polar bears and ringed seals

(Alaska Nanuuq Commission) Charlie Johnson has been working with John Reynolds to start collecting ice-seal samples to analyze changes in predator/prey diet changes using fatty acid signatures.

B.3.2. Movements, habitat use, and foraging behavior of bearded seals in the Chukchi and Bering Seas

Objective: To document the seasonal movements, foraging behavior, and important habitats of bearded seals in Kotzebue Sound, the Chukchi Sea, and Bering Sea.
Justification: Bearded seals are an important subsistence resource, a key ecological component of the arctic marine ecosystem, and vulnerable to climate change because of their strong association with sea ice. Their seasonal movements, habitat use, and diving behavior have never been documented in Alaskan waters.
Methods: In 2004-2006, young bearded seals were captured in Kotzebue Sound using large-mesh tangle nets. The seals were instrumented with Satellite-linked Dive Recorders (SDRs) and then released. Information on the seals' movements and diving behavior were transmitted back to researchers via the ARGOS satellite system and analyzed. This project involved direct collaboration between subsistence hunters and scientists, especially in capturing and tagging seals. The initial program, developed with the Kotzebue IRA, will be expanded as funding allows, to Shismaref and other communities where opportunities exist for this type of collaborative research.
In 2008-1012, this research will be continued with the goal of extending the sample to adult bearded seals, which have yet to be live-captured and satellite-tagged in Alaska. This work, funded by the Minerals Management Service will also be a collaborative project between scientists and subsistence hunters. In early 2008, a workshop will be held to identify the most promising opportunities for capturing bearded seals and to refine the plan for further field work.
Products:

Cameron, M., F. Frost, A. Whiting, C. Schaeffer, B. Delong, J. Goodwin, G. Sheffield. 2005. Winter movements of female young-of-the-year bearded seals (*Erignathus barbatus*) in Kotzebue Sound and the Chukchi Sea. Page 103 *in* Marine Science in Alaska: 2005 Symposium Abstracts. January 24-26, 2005.

Frost, K.J.; M.F. Cameron, M.A. Simpkins, C. Schaeffer, A. Whiting. 2005. Diving behavior, habitat use, and movements of bearded seal (*Erignathus barbatus*) pups in Kotzebue Sound and the Chukchi Sea. Abstract. 16th Biennial Conference on the Biology of Marine Mammals. December 2005. Society for Marine Mammology.

Cameron, M. F. Habitat use and seasonal movements of bearded seals in Kotzebue Sound, Alaska. 2005. Alaska Fisheries Science Center Quarterly Report January-March, P.18.

Five-year project status: Funded by USFWS Tribal Wildlife Grant and NMFS/NMML, 2004-2005. Partially funded 2006-2007. Funded FY2008-2012.

Project partners: Kotzebue IRA, Alaska Marine Ecosystems Research (Kathy Frost), ADF&G, NMFS/NMML, Ice Seal Committee, Minerals Management Service

B.3.3. Movements, habitat use, and foraging behavior of spotted and ringed seals in the Chukchi and Bering Seas

Objective: To document the seasonal movements, foraging behavior, and important habitats of spotted and ringed seals in Kotzebue Sound, the Chukchi Sea, and the Bering Sea.

Justification: This work has expanded upon the existing collaboration between Kotzebue IRA, ADF&G, and NMFS by taking advantage of opportunities to study spotted and ringed seals when they are captured incidentally to the capture efforts of the bearded seal project, B.3.2.

Methods: Spotted and ringed seals are captured in large-mesh tangle nets, instrumented with Satellite-linked Depth Recorders (SDRs) and then released. Information on the seal's movements and diving behavior are transmitted back to researchers via the ARGOS satellite system and analyzed for relationships with bathymetry, sea ice, and other environmental features.

Products: Peer-reviewed publications anticipated

Five-year project status: Partially funded 2006-2008. Unfunded 2009.

Project partners: Kotzebue IRA, ADF&G, NMFS/NMML

B.3.4. Movements, habitat use, and foraging behavior of ribbon seals in the Bering Sea

Objective: To document the seasonal movements, foraging behavior, and important habitats of ribbon seals.

Justification: Ribbon seals are a key ecological component of sub-arctic and arctic marine ecosystems, and a subsistence resource for some of the Alaska Native communities of northern and western Alaska. Yet less is known of their abundance, seasonal distribution, migration, or food habits than of any other species of Alaska pinniped. Of particular interest are their migration routes after the molt (i.e., do they follow the ice edge as it melts northward through the Bering Strait into the Chukchi and Beaufort Seas, or do they remain pelagic in more southerly ice-free areas where they may compete with major commercial fisheries?). The distributions and densities of ice seals are highly sensitive to suitable sea ice conditions, and as such, may be particularly vulnerable to climate change. Changes in sea ice extent have been non-uniform; therefore, the effects on seals are likely to occur on regional scales.

Methods: Ribbon seals are tagged with satellite-linked dive recorders (SDRs), oceanographic-sampling SDRs (OSSDRs) tags, or satellite position-only (SPOTs) for three purposes: 1) to provide information on seals' habitat selection, 2) to sample oceanographic conditions in the study area, and 3) to provide information on the foraging and haul-out behavior of seals. The OSSLTDRs will serially sample and transmit water column temperatures at depth throughout seal dives (sampling the upper 500 m of the water column). These instruments will also provide histograms of seal dive depths during foraging and the geographic locations of seal movements. Ribbon seals will be captured, restrained, instrumented, and released on the ice floes where they are hauled out. This project will focus on physical environmental features associated with habitat and resource selection of ribbon seals. This will be done by using space-time animal movement models and spatial resource selection models to analyze bathymetric, sea ice, and oceanographic parameters associated with location data collected from OSSLTDRs. The results of this analysis will improve our understanding of the ecological factors influencing the distribution and habitat selection of ribbon seals integrated over a wide range of spatial and temporal scales.

In 2005, 10 ribbon seals were tagged near Kamchatka in the western Bering Sea. In 2006, 10 were tagged in the eastern Bering Sea. And in 2007, 27 ribbon seals were tagged.

Products:

Cameron, M, J. L. Bengtson, P. L. Boveng, V. N. Burkanov, B. S. Stewart, and A. Trukhin. 2006. Ribbon seal habitat selection and seasonal movements. Abstract. Alaska Marine Science Symposium, 22-25 January 2006, Anchorage, AK.

Cameron, M. F. 2005. Habitat use and seasonal movements of ribbon seals in the Bering Sea and North Pacific. Alaska Fisheries Science Center Quarterly Report April-May, Pages 20-21.

Five-year project status: Funded 2006-2008. Partially funded 2009.

Project partners: NMFS/NMML, Ice Seal Committee

B.3.5. Analysis of trends in sea ice extent, snow cover, and dates of snow melt as a context for interpretation of ecological studies on arctic seals

Objective: Develop and make available temporal and spatial data sets describing sea ice and snow cover characteristics relevant to the ecology of arctic ice seals.

Justification: Data on sea ice, snow cover, and particularly dates of snow melt are required on a fine spatial scale for interpretation of past seal surveys (Kelly et al. 2003), for design of future surveys, and for assessment of likely responses to climate change. Development of appropriate datasets will require special expertise not available in the community of seal researchers.

Methods: Contract with researchers or organization with special expertise, for example Space Monitoring & Bioecoinformation Systems Sector, Institute of Ecology, Russian Academy of Sciences (Dr. Gennady Belchansky).

Products:

Belchansky, G., V.A. Eremeev, N.N. Kozlenko. I.N. Mordvintsev and N.G. Platonov. 2006. Assessing sea ice habitats of arctic pinnipeds in relation to climate change. Final Project Report. National Marine Mammal Laboratory, Alaska Fisheries Science Center, 7600 Sand Point Way NE, Seattle, WA 98115. 11pp.

Five-year project status: Partially funded, 2006. Unfunded 2007-2009.

Potential project partners: NMFS/NMML, University of Alaska Southeast

B.3.6. Assessing ringed seal abundance and sea-ice characteristics: Comparisons of unmanned aircraft systems (UAS) and sensors.

Objective: Test and compare unmanned aircraft systems and sensors for their suitability in monitoring the abundance of ice seals. Data collected on the operational characteristics of the UASs and sensors during this project will be used to plan and prepare for an aerial survey of ice and seals in 2009 using a UAS based on a NOAA research vessel in the Bering Sea.

Justification: Current and reliable estimates of ice seal minimum population sizes, total abundances and distributions are not available because of the costs and/or dangers involved in mounting traditional aerial surveys with human observers. Although there have been sporadic aerial surveys to estimate ice seal densities along the coastline of the Beaufort and Chukchi Seas, the costs of surveying more frequently and the risks of surveying farther off shore have precluded reliable assessment of the status and trends for these populations. Recent advances in unmanned aerial systems (UAS) technology may soon allow large-scale, systematic surveys of sea ice in the Beaufort, Chukchi and Bering Seas to be undertaken.

Methods: The primary concerns for using UASs in the arctic to survey for ice seals are: 1) the ability of the sensors to record the presence of seals on the ice, 2) the combined ability of sensors and aircraft to provide sufficient areal coverage within time constraints imposed by seal life history events and seasonal melting of ice, and 3) the ability of the aircraft to operate in the extreme weather conditions of the north. We intend to evaluate two different models of UASs over known ringed seal habitat on the shore-fast ice within the restricted airspace (2 Nmi. radius) at Oliktok Point, AK. Digital and infrared cameras mounted on the UASs will record geo-referenced images of the sea ice and seals below. These images will be analyzed for seals and their breathing holes and sightings will be compared to visual observations made by researchers on land or ice using binoculars. Concurrently, the flight characteristics (e.g., stability, speed, duration payload, effects of icing), of the two UASs will be compared with respect to the effects of weather conditions. To demonstrate additional capability to acquire science-quality information on surface conditions, researchers will analyze the level of physical detail provided by the camera systems. Potential for mapping the time and space variations in albedo as a function of ice conditions will be done using nadir-viewing spectrometers and a laser system for surface height profiling. This will be accompanied by visual observations of ice conditions.
Products: Field report in July 2008 and final report in December 2008.
Five-year project status: Funded 2008. Unfunded 2009.
Project partners: NOAA UAS Program, University of Alaska (CIFAR), University of Colorado (CIRES)

B.3.7. Densities and distribution of ribbon, spotted, and bearded seals in the eastern Bering Sea

Objective: Determine the densities and numbers of ribbon, spotted, and bearded seals in the sea ice of the Bering Sea in spring time.
Justification: The Bering Sea Ecosystem Study (BEST) and the Bering Sea Integrated Ecosystem Research Program (BS-IERP) are major collaborative programs funded by NSF and NPRB, respectively, to better understand the Bering Sea ecosystem from top (humans) to bottom (climate and primary production). Because seals are important upper predators in this system that represent a direct link to the human component, it is essential to understand the trophic links that involve seals. Models used to investigate hypotheses about this system cannot be parameterized for seals without estimates of fundamental quantities such as densities, which are currently lacking.
Methods: Aerial line-transect surveys will be flown by helicopter from a U.S. Coast Guard icebreaker in spring of 2007 and 2008. The aerial survey effort will be supplemented by line-transect observations from the icebreaker and from a NOAA Fisheries research vessel. To correct for seals missed because they are in the water during surveys, the haul-out behavior of seals is being quantified in related studies using satellite telemetry.
Products:

Cameron, M.F and P.L. Boveng. 2007. Abundance and Distribution Surveys for Ice Seals Aboard the USCG Healy and the Oscar Dyson, 10 April – 18 June 2007. Alaska Fisheries Science Center Quarterly Research Reports. April – June 2007. http://www.afsc.noaa.gov/Quarterly/amj2007/divrptsNMML3.htm

Boveng, P.L., J.M. London and M.F. Cameron. 2007. Telemetry of ice seals captured during the USCG Healy and Oscar Dyson research cruises in the eastern Bering Sea. Alaska Fisheries

Science Center Quarterly Research Reports. April – June 2007. http://www.afsc.noaa.gov/Quarterly/amj2007/divrptsNMML4.htm

Five-year project status: Funded by NMFS/NMML and NSF 2007. Partially funded 2008-2009.

Project Partners: NMFS/NMML, Ice Seal Committee

B.4 Education and outreach

B.4.1. Traditional hunting workbook – ice seals

Objective: A workbook on traditional ice-seal hunting in the Yukon-Kuskokwim region will be produced that can be used by teachers in the region. Printing of the workbook will require additional funds.

Justification: Young hunters need to know the traditional ways of hunting, the tools used in hunting, and the ways to prepare seals.

Methods: Produce outline and draft workbook for review by hunters and elders.

Products: Draft

Five-year project status: Funded 2005-06.

Project Lead: ADF&G

Partners: NMFS/NMML, IUM, Ice Seal Committee

C. RESEARCH NEEDS AND PROJECT PROPOSALS

C.1 Population identity and status

C.1.1. Population structure of ringed seals (*Phoca hispida*) in the Chukchi and Beaufort seas

Objective: Determine the genetic diversity of ringed seals and the scale of stock structuring in Alaska.

Justification: Recent observations of tagged ringed seals indicate that they maintain small breeding home ranges (averaging 1 km^2) and that they use the same breeding sites in successive years. If the sites breeding seals return to are, in fact, their own natal sites, then the population likely consists of multiple demographically isolated units. This work would expand the scope of B.1.2 by supporting sampling and analysis of DNA over a larger area.

Methods: DNA samples (mtDNA and micro satellites) will be collected from breeding ringed seals in three or more sites within Alaska and two or more sites outside of Alaska. If feasible, a sampling network will be established to involve community members in the research. Genetic diversity will be analyzed for each breeding site.

Products:

Five-year project status: Proposal pending (ADFG Nongame Program)

Potential project partners: University of Alaska Southeast, Ice Seal Committee, North Slope Borough, Central Michigan Univ., Dept. Fisheries and Oceans (Canada), Finnish Game and Fisheries Research Institute

C.2 Mortality and harvest

C.2.1. Subsistence harvest monitoring

Objective: Develop regional or community-based plans to document harvest information (harvest # by sex and species, hunter effort, ice conditions during hunt).
Justification: Although many coastal villages rely on seals for meat, the number of seals taken each year is unknown. Some household surveys have been conducted at a few locations in the past, but there is no consistent effort or support for harvest monitoring.
Methods: Need to be developed during a Harvest Monitoring Workshop. Household surveys and/or harvest calendars are possible methods.
Products: Annual harvest report.
Five-year project status: Unfunded
Potential project partners: Ice Seal Committee Village IRAs, ADF&G, NMFS.

C.2.2. Nutrients and contaminants in bearded seal based foods, and assessment of risks and benefits to human consumers

Objective: 1. Document the affects of food processing on nutritive value (essential elements, fatty acids, etc.) and select contaminants concentration (i.e., PCBs, DDTs, mercury, cadmium) in tissues of subsistence use bearded seals and relate these to known exposure criteria (tolerable daily intake levels), and 2. Determine nutrient concentrations in bearded seals used as food for general human health (compare to recommended daily allowances or intake criteria) and that likely offset (prevent) diabetes, obesity, and cardiovascular disease.
Justification: Information on the bioavailability (the absorption into the body or bloodstream) of nutrients and contaminants from subsistence based foods, especially ice seals, is lacking and hampers our assessment (benefits and risks) of the subsistence diet.
Methods: We will work in very close coordination with the hunters, investigators, project manager (propose ADF&G, Lori Quakenbush), and students to collect samples from animals as they are butchered during normal subsistence activities (communities for potential participation include Barrow, Kotzebue, or Point Hope). Animals will be closely examined and sampled for a general health assessment (gross and histologic assessment) to assure data are properly interpreted in the context of the condition of the animals. Procedures as published in Hoekstra et al. (2002a,b,c; 2003a,b) and Becker et al. (1991) will be followed for collection of contaminants and nutrients analyses samples.

Proposed sampling scheme (scheme could change with input from community):
Tissue → Raw, Cooked, Rendered → Contaminants & Nutrients measured
Seal:
Blubber – raw, oil
Muscle – raw, dried, cooked (2 or more methods)
Liver (optional, for Committee and/or community to consider)

This sampling scheme represents 2 or 3 tissue types and 6 or more (8 if liver included) processed food items per seal; and 5 individual seals will be targeted. Thus a total of 30-40 samples for chemical analyses will be proposed to be collected. Sample collection can be in coordination with ongoing ADF&G efforts and/or include UAF personnel or training of community personnel

in Fairbanks. Samples of seals will be shared with existing projects coordinated by Lori Quakenbush and/or Gay Sheffield (Alaska Department of Fish and Game, Fairbanks).

Chemical Analyses (briefly)
Organochlorines will be determined as in Hoekstra et al. (2002b,c; 2003a,b). Mercury (total, organic) analyses will be conducted at the UAF by a graduate student (Ms. Sara Moses) under the supervision of O'Hara using published techniques (Woshner et al., 2001a,b). Basic or proximate composition (water, lipid, etc.) will be determined by O'Hara and the student at the UAF to grossly describe the compositional changes that occur as a part of food preparation. This is very important to consider as changes in the major components will definitely alter the concentrations of the various contaminants and nutrients (as wet weights, dry weights, and lipid adjusted weights). Nutrients will be analyzed as pooled samples to save costs and to achieve the appropriate tissue mass to evaluate the high number of nutrients to be determined. We propose to use Maxaam Analytical that was recently used for bowhead whale tissues to allow for direct comparison. Thus endpoints include (g/100g) moisture, fat, protein, ash, carbohydrates, cis-polyunsaturated fatty acids (PUFAs), cis-monounsaturated fatty acids (MUFAs), saturated fatty acids, trans-fatty acids, total sugars, glucose, sucrose, maltose, lactose, and total dietary fiber. Components measured at mg/ 100g are cholesterol, vitamin C, Ca, Cr, Cu, Fe, Mg, Mn, Mo, P, K, Se, Na, and Zn; and at ug/100g are beta carotene, and retinol (Vitamin A).
Products: Data will be presented to the community where sampling takes place, ADF&G (Quakenbush et al.) and the Ice Seal Committee prior to broader dissemination and publication. At least one peer-reviewed manuscript will be prepared and submitted to a journal following review by all concerned parties.
Five Year Project Status: Unfunded
Project Partners: UAF Institute of Arctic Biology, Ice Seal Committee, Local Tribes, ADF&G

C.3 Habitat and climate change

C.3.1. Compile an annotated list of existing programs collecting or using seal tissues
Objective: Providing a list of programs that are addressing ice-seal health and status issues, that communities and agencies can contribute tissues and/or data.
Justification: A review of ongoing programs would avoid potential duplication of research efforts. Contributions of tissues and/or data could be a cost-effective way to enhance knowledge and address concerns regarding ice seals.
Products: An annotated list of existing programs, objectives, timelines, and tissues/data requested.
Five-Year Project Status: Unfunded
Potential project partners: Ice Seal Committee, NMFS, ADF&G

C.3.2. Under-ice foraging ecology of ringed seals
Objective: Determine the importance of prey on the sea floor, in the water column, and on the under side of the ice to the choice of breeding sites by ringed seals.
Justification: Recent observations of tagged ringed seals indicate that they maintain small breeding home ranges (averaging 1 km^2) and that they use the same breeding sites in successive years. Concentrations of prey under the ice may determine the most advantageous breeding sites.

Methods: Ringed seal foraging will be observed using video cameras mounted to seals diving under the ice. Foraging dives will be tracked by way of ultra sonic transmitters. Prey populations will be sampled and quantified using bottom grabs and SCUBA.
Products: Pending
Five-year project status: Proposal pending (National Undersea Research Program)
Potential project partners: University of Alaska Southeast, University of Alaska Fairbanks, National Geographic Society, Florida International University

C.3.3. Develop methods for residents of coastal communities to record and communicate observations of animal and environmental conditions
Objective: 1) Record current animal and environmental observations from coastal communities and 2) develop means to share this information between co-management Native organizations.
Justification: Information regarding the health and status of ice seal species can be obtained from the observations of coastal residents including general body condition, movements, timing, and behaviors. Data collected from this project would provide a means to document current conditions and augment biomonitoring studies that are based on the analyses of animal tissues.
Products: Annual report of observations by community.
Five-Year Project Status: Unfunded
Potential project partners: Ice Seal Committee, NMFS, ADF&G

C.3.4. Development of live-capture techniques for telemetry and ecological process studies of arctic ice seals
Objective: Improve capabilities for studies requiring access to live seals for sampling and deployment of telemetry devices, and strengthen the involvement of Alaska Native communities in research on subsistence resources.
Justification: A major reason for the paucity of information about arctic ice seals is the difficulty of live-captures for sampling and placement of telemetry instruments. Progress can likely be improved by close collaborations between scientists and hunters throughout the arctic to exploit particular situations that afford access to seals. Ribbon and bearded seal research, especially, would benefit from new means of live-capture.
Methods: The methods for this project will vary according to local opportunities. Opportunities already taken include collaborating with Alaska Native hunters in Kotzebue to capture bearded and spotted seals, and with Russian fishermen to capture ribbon seals on the coast of Kamchatka.
Products:
Bengtson, J.L., M. F. Cameron, P.L. Boveng, V.N. Burkanov, B.S., Stewart, A. Trukhin. 2005. Ribbon seal habitat selection and seasonal movements. Abstract. 16th Biennial Conference on the Biology of Marine Mammals. December 2005. Society for Marine Mammalogy.
Five-year project status: Funded, 2005. Unfunded, 2006-2007.
Project partners: NMFS/NMML, AK Native organizations, ADF&G

C.3.5. Effects of long term changes in ice cover on the abundance, demography, and reproductive ecology of Alaskan bearded seals.
Objective: To determine how changes in ice cover are influencing the ecology and demography of male bearded seals over three decades (1980's, 90's and 2000) off Point Barrow Sound, Alaska.

Justification: A growing body of literature concerning the effects of climate change on marine organisms suggests that species are either exhibiting rapid changes in their ecology or going extinct. However, without a good understanding of the ecology of bearded seals it will be impossible to determine how changes in ice conditions are affecting this species. This project will have broad implications in terms of the future management and conservation of this and other Arctic pinniped species. Better knowledge of how ice-dependent seals are affected by changing ice cover may help us to understand this and other similarly dependent species as well.
Methods: Underwater acoustic recordings were made at Point Barrow Sound, Alaska over eight years (1980, 1984, 1985, 1986, 1992, 1993, 2000 & 2001) from April through to the end of May in each year. The original focus of these recordings was to determine estimates of abundance for bowhead whales, *Balaena mysticetus,* off Point Barrow during the spring migration by combining acoustic and visual count surveys. The timing of these acoustic recordings overlapped with the bearded seal, *Erignathus barbatus,* mating season. Male bearded seals produce stereotypic underwater calls during the mating season, which can be used as a tool for studying male mating tactics. Therefore, the bearded seal vocalizations present on these recordings provided an invaluable opportunity for studying long term mating tactics in this species. Bearded seal trills exhibit clear individual variation between males using their vocal parameters as a measure of call variability. The location of each vocalization can be estimated using measurements of the arrival time difference between the occurrences of the same sound on different pairs of hydrophones. Visual surveys for bowhead whales were run in conjunction with the acoustic surveys. During these surveys, hourly data were collected on ice cover by estimating the percentage of open water off the fast ice. Mark-recapture techniques, demographic analyses and generalized linear (or additive) models with appropriate spatial and /or temporal correlation structure(s), will be used to describe the relationships between the number of individuals present, their mating tactic and remotely sensed environmental data (e.g. ice cover) over the study period. Comparative analyses will explore the relationship between male behavior and ice cover at Svalbard and Alaska. Based on the findings of these analyses and predictions concerning the effects of further reduction in ice cover will be made.
Products: Resulting products will be publications in the peer reviewed literature in such journals. These results will also be presented at least one international conference
Five-year project status: Unfunded
Potential project partners: Cornell University, NMFS/NMML, Ice seal Committee

C.3.6. TEK - Inupiat Observations of Ice Seals and Climate Change in Barrow, Alaska
Objective: To investigate and report on traditional ecological knowledge (TEK) and observations of changes in sea-ice, climate, and the effects on ice seals near the Inupiat hunting community of Pt. Barrow, Alaska.
Justification: Sea-ice provides critical habitat for polar bears, ice seals, and other marine life. Recent changes in air and seawater temperature, annual snowfall, snow-coverage, snow-melt, ice extent and concentration also play a critical role in quality habitat for marine life. These accelerating changes in both arctic climate and sea-ice pose considerable risks to coastal Alaska Native subsistence hunters and users. There exists a knowledge gap from Inupiat ice seal hunters related to observations of ecosystem changes along Alaska's northern coast. Documenting this information would provide critical support for natural resource decision-making bodies regarding future policies, actions, and recommendations concerning ice seals. A final traditional knowledge report will not only compliment current geophysical and biological sciences, but will meet the

recommendations of several international and domestic arctic organizations that include the Arctic Council and the U.S. Marine Mammal Commission.
Methods: Representatives from the ice seal committee will travel to Barrow, Alaska to discuss planning and development with the Natural Resources Department staff of the Inupiat Community of the Arctic Slope. Examples of similar marine mammal TEK projects will be reviewed for planning. The Alaska Nanuuq Commission will contract services with ICAS who will sub-contract to an interpreter, ethnographer, and/or anthropologist to help implement the project to interview, investigate and report on traditional ecological knowledge (TEK) and observations of changes in sea-ice, climate, and the effects on ice seals near the Inupiat hunting community of Pt. Barrow, Alaska.
Products: A final traditional knowledge report
Five-year project status: Unfunded
Potential project partners: Ice seal Committee

C.4 Education and outreach

C.4.1. Education and outreach
Objective: Develop an education program for teaching traditional hunting methods, biology, and conservation within the school system. Similar to what the North Slope Borough has done with whaling where the students receive school credit for participating in subsistence activities. Children learn information on ice types, animal biology, subsistence practices, and weather. Outreach objectives include projects that would share the importance of seals to the subsistence lifestyle and the importance of subsistence to rural Alaskans.
Justification: Younger hunters are not learning the traditional ways of hunting and conservation. Materials available to teachers would help. Outreach is necessary to help urban people understand the importance of seals and seal hunting to coastal communities in Alaska.
Methods: Work with educators, hunters, and elders to develop materials for schools and for outreach.
Products: A curriculum for schools to use. Posters, published stories for outreach.
Potential project partners: Ice Seal Committee, Village IRAs, ADF&G, NMFS.

D. COMPLETED PROJECTS

In response to Project Chariot, a 14-month field study of ice-associated seals was conducted near Kivalina in the mid 1960s (Johnson et al. 1966). That study elucidated food habits, age structure, reproductive patterns, and other aspects of the basic biology of ringed, ribbon, spotted, and bearded seals.

In the mid 1970s – 1980s, the Alaska Department of Fish and Game, the University of Alaska Fairbanks, and the National Marine Fisheries Service undertook a series of studies concerning ice-associated seals and offshore oil development. They investigated feeding ecology (Lowry et al. 1978; West et al. 1979; Frost and Lowry 1980; Lowry and Frost 1981; Bukhtiyarov et al. 1984; Simpkins et al. 2001a), distribution and density (Burns and Harbo 1977; Braham et al. 1984; Frost et al. 1988, 2002; Kelly et al. 2000, 2003), habitat use (Burns and Eley 1978; Burns and Frost 1979; Burns et al. 1981a,b; Burns and Kelly 1982; Kelly and Quakenbush 1990;

Kingsley et al. 1990), diving behavior (Elsner et al. 1989; Wartzok et al. 1992; Kelly 1996; Kelly and Wartzok 1996; Simpkins et al. 2001b,c), and responses to industrial development (Fay et al. 1979; Burns and Kelly 1982; Kelly et al. 1986; Frost and Lowry 1988; Frost et al. 1988; Kelly et al. 1988).

Other projects, mostly completed within the past 5-10 years, are described in more detail, below.

D.1 Population identity and status

D.1.1. Traditional ecological knowledge of seals in Norton Bay, Alaska

Objective: Document traditional knowledge about seals in the Norton Bay area.
Justification: Knowledge of hunters and elders, of the distribution, abundance, and natural history of seals is useful in better understanding the Norton Bay region's seal populations and any changes that have occurred. Documenting this knowledge allows local residents to express their views on the status of seal populations so that their understanding and perspective can be taken into account in research and management. It also provides for collaboration between residents of seal hunting communities, scientists, and wildlife managers, that is an essential component of ensuring sustainability of the resource.
Methods: A workshop was held in Shaktoolik, Alaska, February 1-5, 1999 to interview participants.
Products:
Huntington, H. P. 2000. Traditional ecological knowledge of seals in Norton Bay, Alaska. Report submitted to the Elim-Shaktoolik-Koyuk Marine Mammal Commission and the National Marine Fisheries Service. Compiled and edited by Henry P. Huntington, translated by Clara Sookiayak.
Five-year project status: Funded by NMFS/NMML. Completed 2000.
Project Partners: NMFS/NMML, Elim-Shaktoolik-Koyuk Marine Mammal Commission

D.1.2. Correction factor for ringed seal surveys

Objective: Determine the proportion of local ringed seal populations included in aerial surveys and estimate the variance in that proportion.
Justification: Aerial surveys have been the primary method of estimating population size and have been used to compare changes in densities of ringed seals over time and space (Burns and Harbo 1972; Frost et al. 1997, 1998, 1999). Survey counts cannot generate estimates of population size with correcting for the portion of the population unseen under snow and ice. Conclusions about population status based on comparisons of densities have been based on the untested assumption that the proportion of populations that are visible is constant.
Methods: Radio telemetry was used to determine the availability of ringed seals for counting during survey periods in the spring of 1999 and 2000. Each time a radio- tagged seal came out of the water, its location and whether or not it was concealed in a subnivean lair or visible on top of the snow was recorded.
Products:
Kelly, B. P. 2005. Correction factor for ringed seal surveys in Northern Alaska. OCS Study MMS 2005. Coastal Marine Institute, University of Alaska Fairbanks.
Five-year project status: Funded by CMI. Completed 2004, pending publication of the manuscript.

Project Lead: University of Alaska Southeast
Partners: NMML/NMFS

D.1.3. Timing and re-interpretation of ringed seal surveys

Objective: Describe inter annual variation in ringed seal behavior and its implications for interpretation of aerial survey counts. Determine the environmental factors influencing the proportion of local populations available to be counted.

Justification: Aerial surveys have been the primary method of estimating population size and have been used to compare changes in densities of ringed seals over time and space (Burns and Harbo 1972; Frost et al. 1997, 1998, 1999). The fraction of the population counted in those surveys is strongly influenced by environmental factors, especially snow conditions. Interpreting past and future survey data requires accounting for those variables.

Methods: Radio telemetry was used to determine the availability of ringed seals for counting during survey periods in the spring of 1999, 2000, 2001, 2002, and 2003. Each time a radio-tagged seal came out of the water, its location and whether or not it was concealed in a subnivean lair or visible on top of the snow was recorded. Snow temperature, air temperature, wind speed and direction, time of day, and calendar date were used in models to predict the fraction of the population visible.

Products:

Kelly, B. P., O. R. Harding, and M. Kunnasranta. 2003. Timing and re-interpretation of ringed seal surveys. p. 32-37. *In* University of Alaska Coastal Marine Institute Annual Report No. 10. OCS Study MMS 2003, University of Alaska Fairbanks and USDOI, MMS, Alaska OCS Region.

Five-year project status: Funded by CMI. Completed 2004, pending publication of the manuscript.

Project Lead: University of Alaska Southeast
Partners: None.

D.1.4. Densities of ringed and bearded seals in the eastern Chukchi Sea

Objective: Determine the densities and numbers of ringed and bearded seals along the eastern Chukchi Sea coast, including the coastal zone and offshore (to 100 n mi), from just north of Bering Strait to Pt. Barrow.

Justification: These two seal species have been historically important to Arctic subsistence hunters, and ringed seals are an important prey species for polar bears. Knowledge of ringed and bearded seal population dynamics, however, is limited in Alaskan waters. Although ringed seals have been surveyed recently in portions of the Bering Sea and the Beaufort Sea, seal densities in the eastern Chukchi Sea have not been assessed since 1985-87.

Methods: Aerial line-transect surveys were flown by fixed-wing aircraft from 23 May-6 June 1999 and 21-31 May 2000. To correct for seals missed because they were in the water during surveys, the haul-out behavior of some instrumented seals was recorded by satellite telemetry. Seal densities were compared in inshore/offshore and north/south strata.

Products:

Bengtson, J. L., L.M. Hiruki-Raring, M.A. Simpkins, and P.L. Boveng. 2005. Ringed and bearded seal densities in the eastern Chukchi Sea, 1999-2000. Polar Biology 28:833-845.

Five-year project status: Funded by NMFS/NMML. Completed 2005.

Project Lead: NMFS/NMML

D.2 Mortality and harvest

D.2.1. Bering Strait seal harvest survey 2002

Objective: Estimate the harvest of ice seals in the Bering Strait Region of Alaska

Justification: Ice seal harvest information has been sporadic and lacking for the Bering Strait region of Alaska.

Methods: A multi-page survey questionnaire was developed to assess ice seal harvests by age class, sex, and month of harvest. Surveyors attempted to census an entire community but generally the participation rate ranged from 10% to 64%. Results included seals harvested by species, by village, by month and struck and lost estimates. The villages included Brevig Mission, Elim, Gambell, Golovin, Shaktoolik, Saint Michael, Savoonga, Stebbins, Teller, and Wales.

Products: A currently unpublished report housed in Kawerak, Inc. has been compiled and used to assist the Kawerak, Inc., Subsistence Program to better understand ice seal subsistence harvests of Bering Strait region communities.

Project Lead: Kawerak, Inc.

Project Partners: NOAA/NMFS

D.3 Habitat and climate change

D.3.1. Ice seal habitat use and selection near St. Lawrence Island

Objective: Evaluate the habitat use of ice seals near St. Lawrence Island to determine whether species associate with certain ice conditions or prefer to remain near rich foraging grounds.

Justification: The design and interpretation of aerial surveys for estimating the density and abundance of ice seals, is improved by knowing the habitats (e.g., ice types and concentrations) preferred by the different species of ice seals.

Methods: Aerial line-transect surveys were conducted from helicopters supported by the U.S. Coast Guard icebreaker *Polar Star.* Seal densities were compared in areas of differing ice concentration, floe sizes, and benthic productivity. Evidence of interactions and segregation among seal species were examined.

Products:

Simpkins, M. A., L. M. Hiruki-Raring, G. Sheffield, J. M. Grebmeier, and J. L. Bengtson. 2003. Habitat selection by ice-associated pinnipeds near St. Lawrence Island, Alaska. Polar Biology 26(9):577-586.

Five-year project status: Funded by the National Science Foundation and the NMML. Completed, 2003.

Project Lead: NMFS/NMML

Partners: ADF&G, Diomede Observatory, National Science Foundation

D.3.2. Ice seal trophic level investigations

Objective: Stable nitrogen and carbon isotope analyses, combined with stomach content data, were used to investigate the varying trophic levels of the diets of ringed, bearded, and spotted seals from Alaska and western Canada.

Products:

Dehn, L. A., G. Sheffield, E. H. Follmann, L. K. Duffy, T. W. Bentzen, G. R. Bratton, V. M. Woshner, P. F. Hoekstra, and T. M. O'Hara. 2002. Feeding Ecology of Arctic phocids – implications for heavy metal dynamics. Presented at American Association for the Advancement of Science (Arctic Division) [Manuscript submitted] - Canadian Journal of Zoology http://arctic.aaas.org/meetings/2002/session-detail.html update published?

Five-year project status: Funded by Diomede Observatory, NSF, UAF, NSB, others? Completed 2004?

Project Lead: UAF Institute of Arctic Biology

Partners: ADF&G

D.3.3. Projects identified at a November 2004 Ice Seal Lab Meeting at UAF

Todd O'Hara – has published papers on contaminants in arctic marine mammals including ice seals. He is currently working on the presence of protozoans in seal intestines (e.g. Giardia) and whether humans can contract it from seals. He is also working on an assessment of Native food. A study to see if the way food is processed affects the nutrient and contaminant levels. Funded by National Institute of Health.

D.3.4. Ringed seal winter ecology and effects of noise disturbance

(Kelly et al. 1986, 1988; Kelly and Quakenbush 1990).

D.3.5. Under-ice movements and sensory basis of hole finding by ringed seals

(Elsner et al. 1989; Wartzok et al. 1992)

D.3.6. Behavior of ringed seals diving under shore-fast sea ice

(Kelly 1996; Kelly and Wartzok 1996; Simpkins et al. 2001a,b,c)

D.3.7. Climate change and ice breeding pinnipeds

(Kelly 2001)

D.3.8. Ice seal movements via telemetry

Objective: Opportunistically capture and place satellite tags on ice seals to record their movements

Justification: Little is known about the movements of ice seals and satellite telemetry is a good tool for tracking seals.

Methods: A ringed seal was captured at its basking hole in the spring at Little Diomede by preventing it from escaping down its hole.

Products:

Sheffield, G. and T. Menadelook Jr. 2001. Capture and movements of an Alaskan ringed seal in the Bering Strait. 14th Conference of the Biology of Marine Mammals, 28 November-3 December 2001. (abstract)

Five-year project status: Completed. Funded by NSF, Diomede Observatory.

Project Lead: ADF&G

Partners: Diomede IRA.

D.3.9. Ice seal contaminant level assessment in tissues consumed by humans

Objective: Determine the levels of trace elements in tissues of ice seals harvested for subsistence.

Justification: Some trace elements (cadmium, lead, and mercury) are toxic to marine mammals and humans. People who rely on marine mammals are concerned about the safety of their food.

Methods: Liver, kidney, and blubber samples are collected during the subsistence harvest. Concentrations of trace elements (cadmium, silver, copper, zinc, total mercury, and methyl mercury were determined in tissues of bearded, ringed, and spotted seals from Alaska and Canada. Age and trophic level were investigated to learn more about the pathways and biomagnification of trace elements among species.

Products:

Reports to the Ice Seal Committee, Village IRAs, State of Alaska Department of Health and Social Services, and scientific publications:

Dehn, L. A., G. Sheffield, E. H. Follmann, L. K. Duffy, V. M. Woshner, and T. M. O'Hara. 2003. Age and diet related distribution of heavy metals in renal and hepatic tissue of ringed, bearded, and spotted seals harvested in Alaska. Proceedings of the 15th Conference of the Biology of Marine Mammals, 14-19 December 2003. (abstract)

Dehn, L. A., G. G. Sheffield, E. H. Follmann, L. K. Duffy, D. L. Thomas, G. R. Bratton, R. J. Taylor, and T. M. O'Hara. 2005. Trace elements in tissues of phocid seals harvested in the Alaskan and Canadian Arctic: influence of age and feeding ecology. Canadian Journal of Zoology 83: 726-746.

Five-year project status: Funded by Cooperative Institute for Arctic Research, NSB/DWM, IAB and Department of Wildlife and Biology UAF, USGS, BASC, and NSF. Completed.

Project Lead: UAF

Partners: ADF&G, Village IRAs, local hunters.

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F.1 SUMMARY OF RESEARCH NEEDS AND FUNDS REQUIRED

Project No.	Project Title	Funded FY08?	Funding Required FY09
B	**CURRENT PROJECTS**		
	B.1 Population identity and status		
B.1.1	Ice seal life history studies	YES	$225K
B.1.2	Population structure and seasonal movements of ringed seals	YES	$102K
	B.2 Mortality and harvest		
B.2.1	Development of a harvest monitoring program for ice seals	YES	$80K
B.2.2	Beaufort Sea ice seal sampling and archival project	YES	$30K
	B.3 Habitat and climate change		
B.3.1	Fatty acid study of polar bears and ringed seals	PARTIAL	$25K
B.3.2	Movements, habitat use, and foraging behavior of bearded seals in the Chukchi and Bering Seas	YES	$K
B.3.3	Movements, habitat use, and foraging behavior of spotted seals in the Chukchi and Bering Seas	PARTIAL	$52K
B.3.4	Movements, habitat use, and foraging behavior of ribbon seals in the Bering Sea	YES	$254K
B.3.5	Analysis of trends in sea ice extent, snow cover, and dates of snow melt as a context for interpretation of ecological studies on arctic seals	NO	$50K
B.3.6	Assessing ringed seal abundance and sea-ice characteristics: Comparisons of unmanned aircraft systems (UAS) and sensors.	YES	$K
B.3.7	Densities and distribution of ribbon, spotted, and bearded seals in the eastern Bering Sea	PARTIAL	$125K
	B.4 Education and outreach		
B.4.1	Traditional hunting workbook – ice seals	YES	$17K
C	**RESEARCH NEEDS AND PROJECT PROPOSALS**		
	C.1 Population identity and status		
C.1.1	Population structure of ringed seals (Phoca hispida) in the Chukchi and Beaufort seas	NO	$90K
	C.2 Mortality and harvest		
C.2.1	Subsistence harvest monitoring	NO	$375K
C.2.2	Nutrients and contaminants in bearded seal based foods, and assessment of risks and benefits to human consumers	NO	$42K
	C.3 Habitat and climate change		
C.3.1	Compile an annotated list of existing programs collecting or using seal tissues	NO	$10K
C.3.2	Under-ice foraging ecology of ringed seals	NO	$196K
C.3.3	Develop methods for residents of coastal communities to record and communicate observations of animal and environmental conditions	NO	$50K
C.3.4	Development of live-capture techniques for telemetry and ecological process studies of arctic ice seals	NO	$125K
C.3.5	Effects of long term changes in ice cover on the abundance, demography, and reproductive ecology of Alaskan bearded seals	NO	$230K
C.3.6	TEK - Inupiat Observations of Ice Seals and Climate Change in Barrow, Alaska	NO	$25K
	C.4 Education and outreach		
C.4.1	Education and outreach	NO	$100K
TOTAL			**$2203K**